Enhanced dust production from Phobos during the Mars encounter of comet Siding Spring

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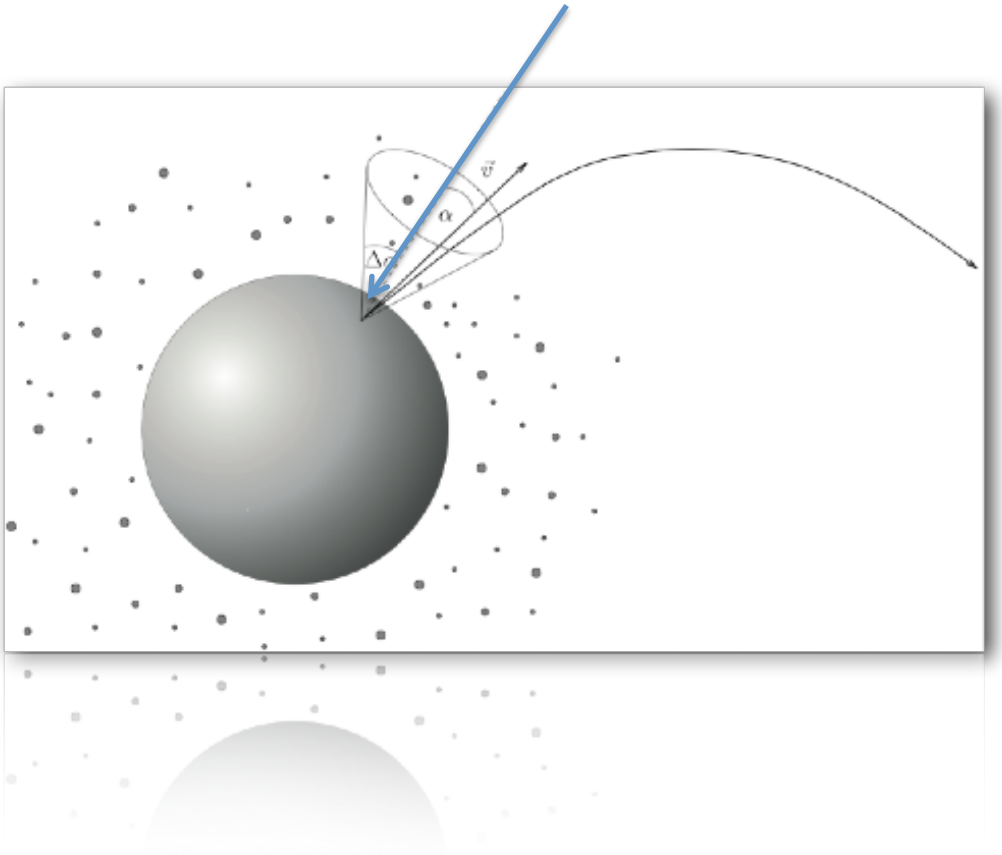
Outline:

1) Dust ejecta clouds
2) Mars dust torus
3) Enhancements by Siding Springs
4) Possible Phobos observations



Basic model

Total mass production:

$$M^+ = FYS$$

Mass distribution of ejecta:

$$N^+(> m) \sim m^{-\alpha}$$

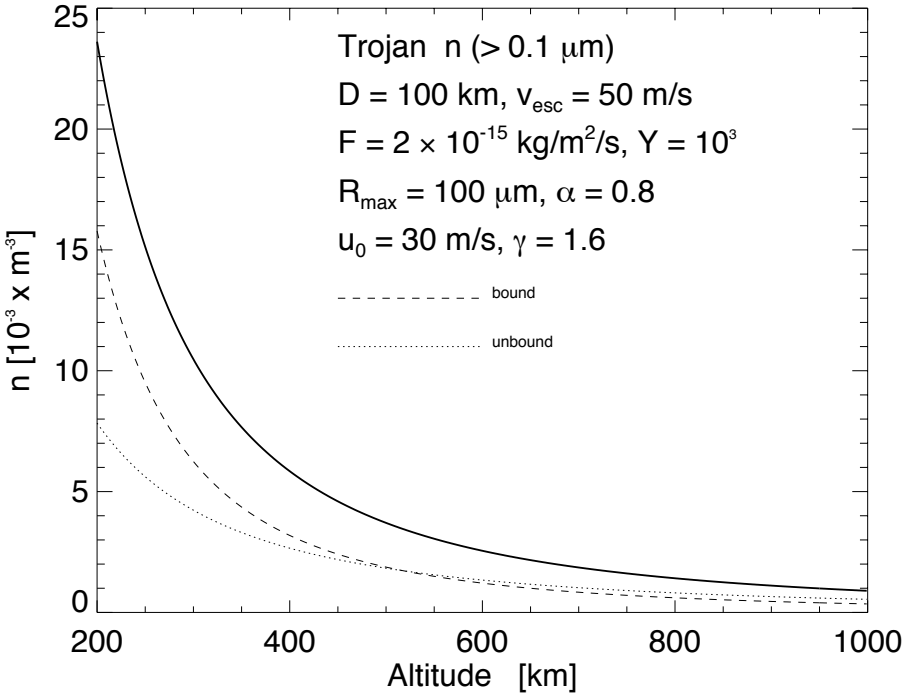
Speed distribution of ejecta:

$$\Psi(> u) \sim (\frac{u}{u_0})^{-\gamma}$$

Smaller objects: unbound cloud

Amalthea and Thebe at Jupiter

Phobos and Deimos at Mars ?

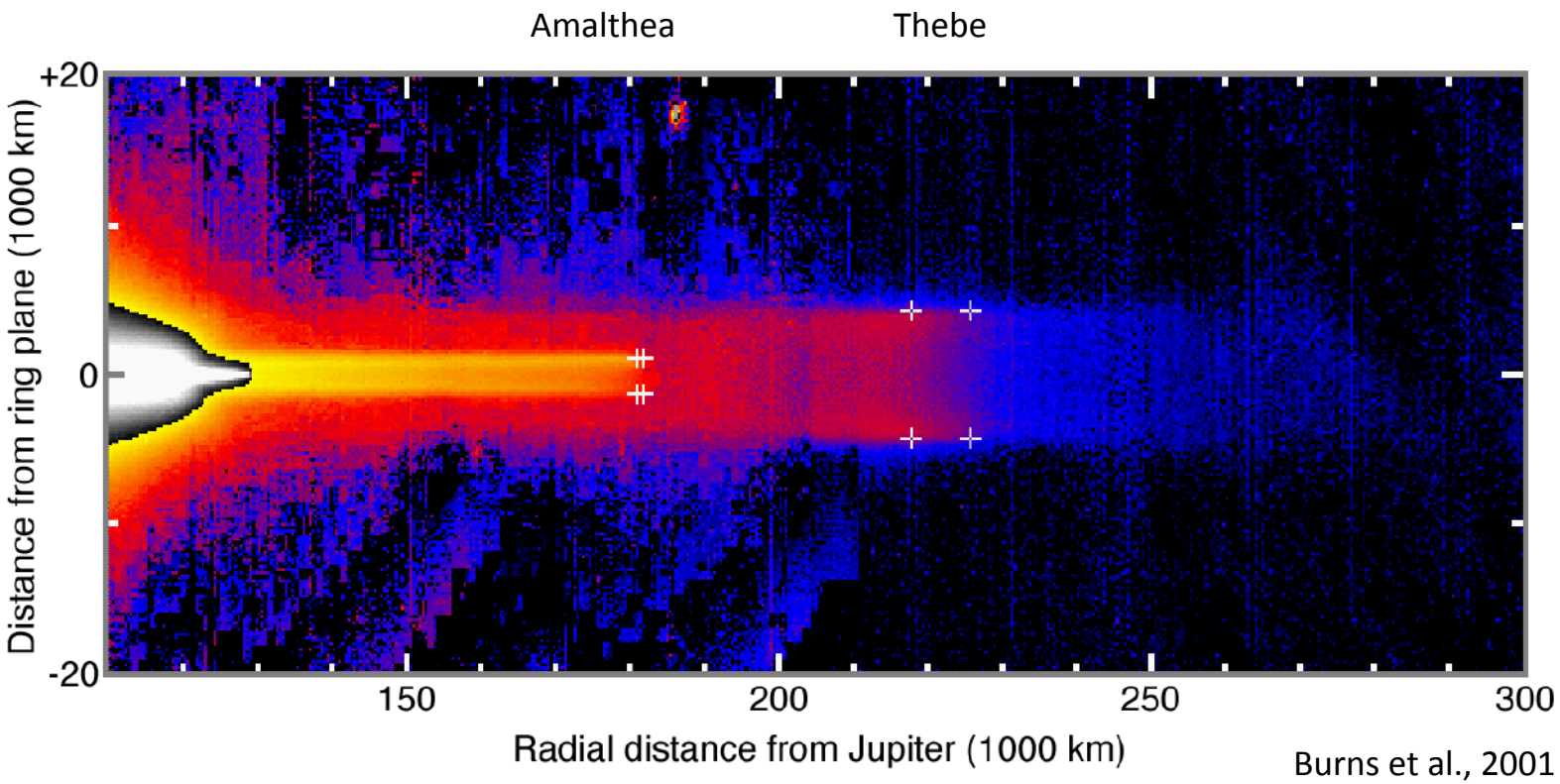


Bigger objects: bound cloud

Jupiter icy moons (Galileo/DDS)

Moon (LADEE/LDEX)

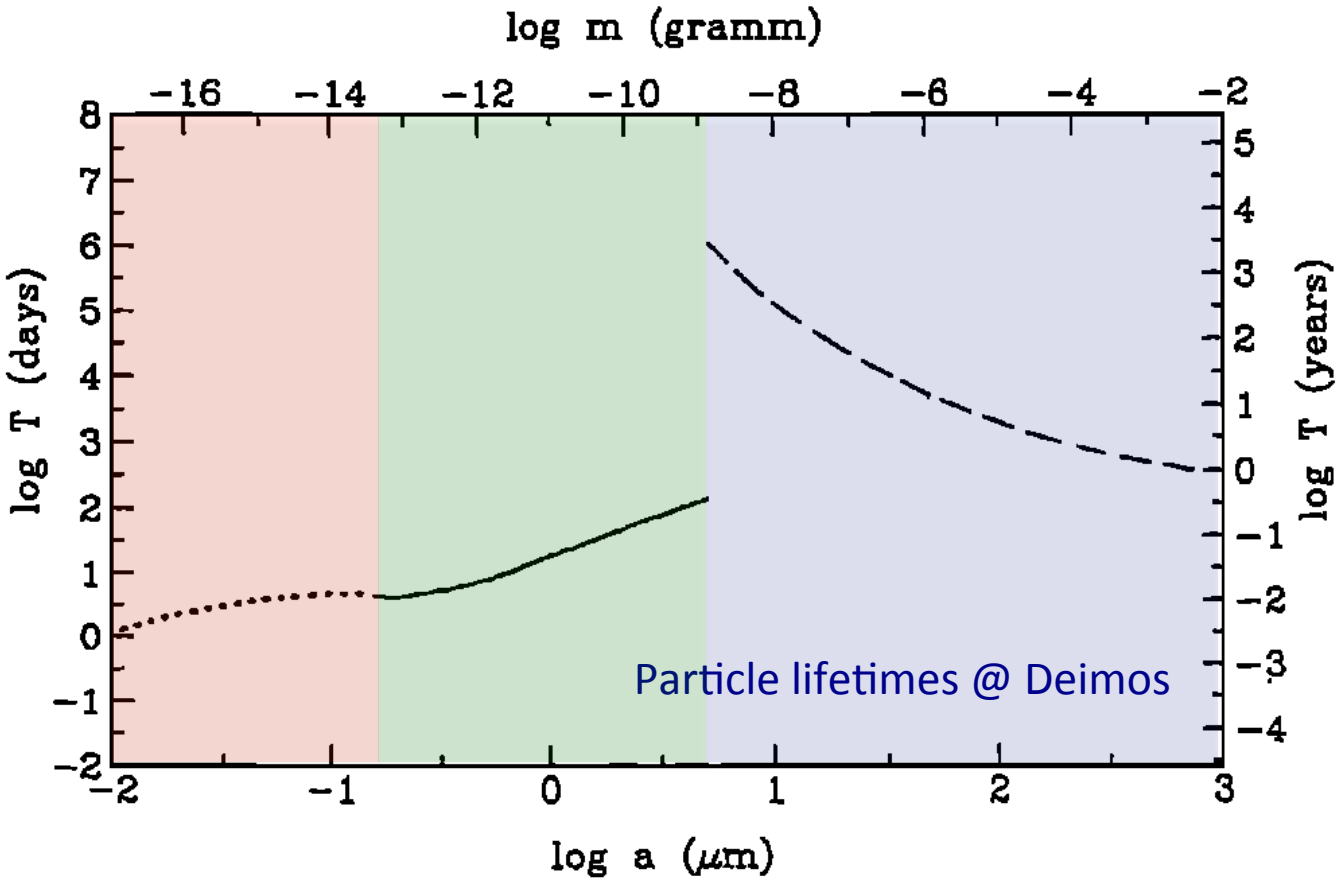
Jupiter's gossamer rings



Burns et al., 2001

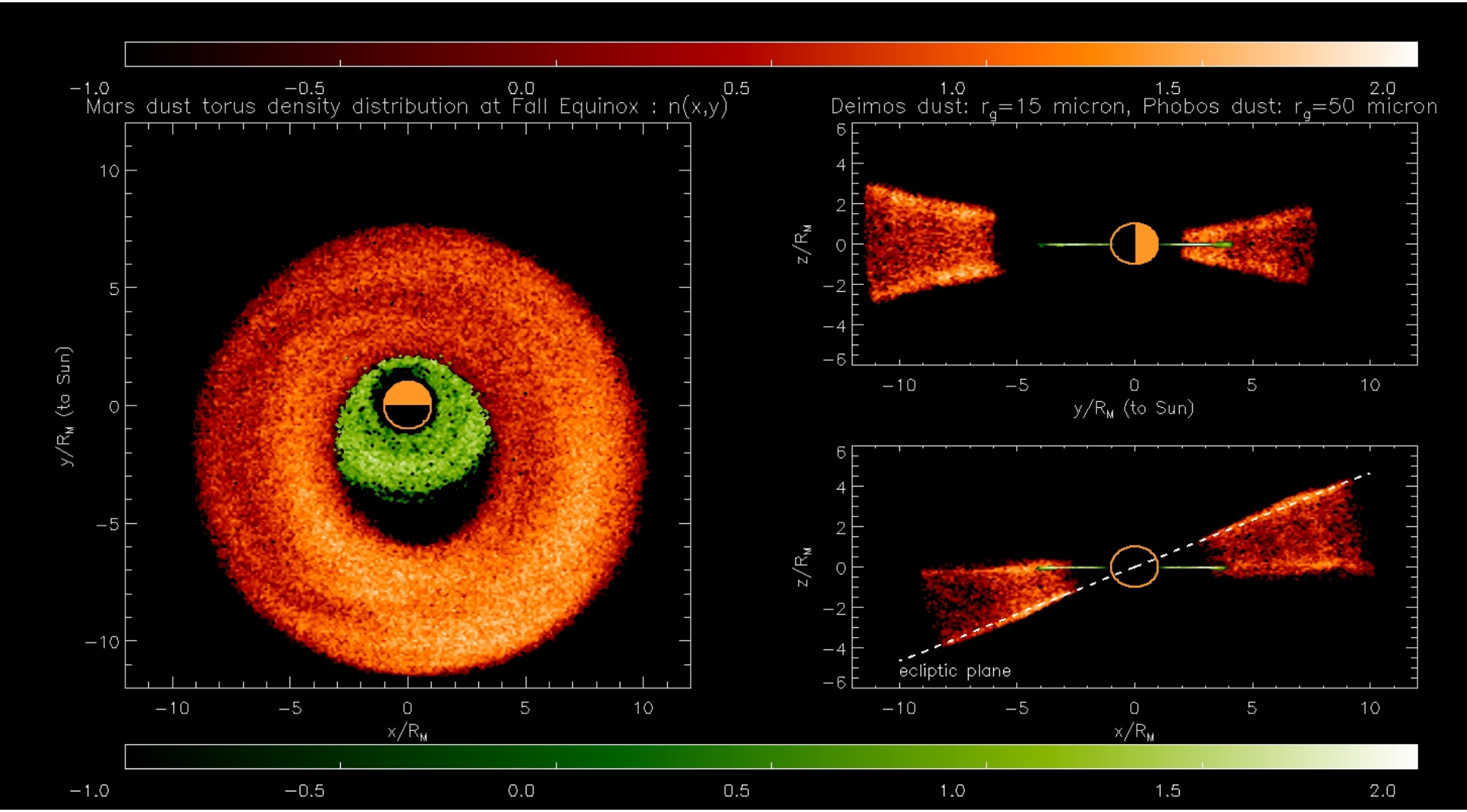
1) Lifetime set by plasma drag

2) Dust ejecta speeds are modest (< km/s)



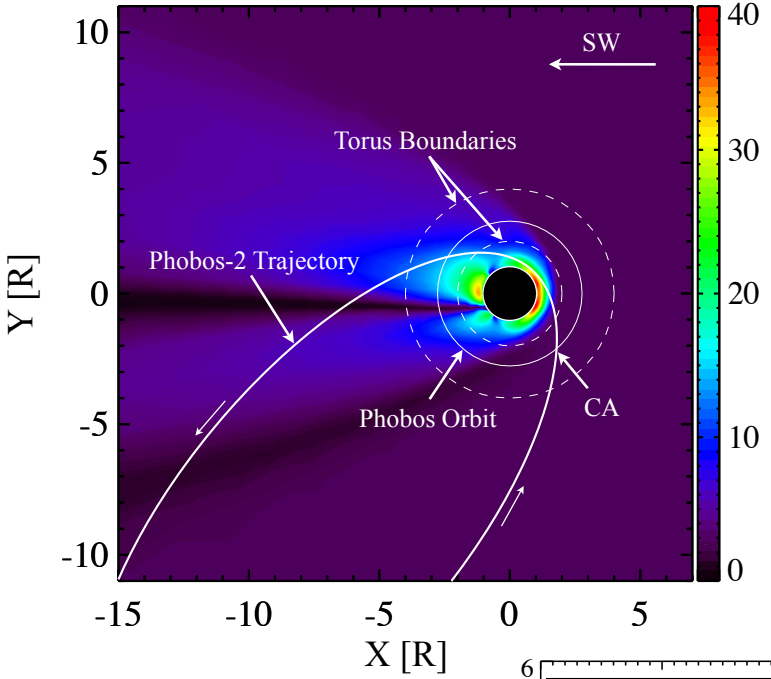
Lifetime is set by: **a)** E&M perturbations; **b)** radiation pressure; **c)** collisions

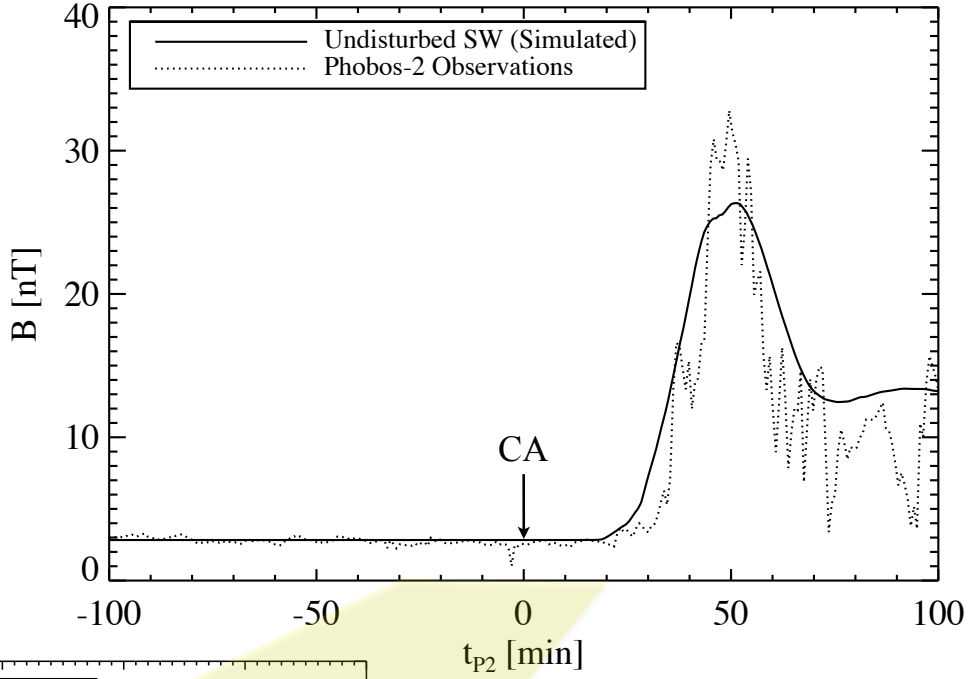
Dust tori at Mars

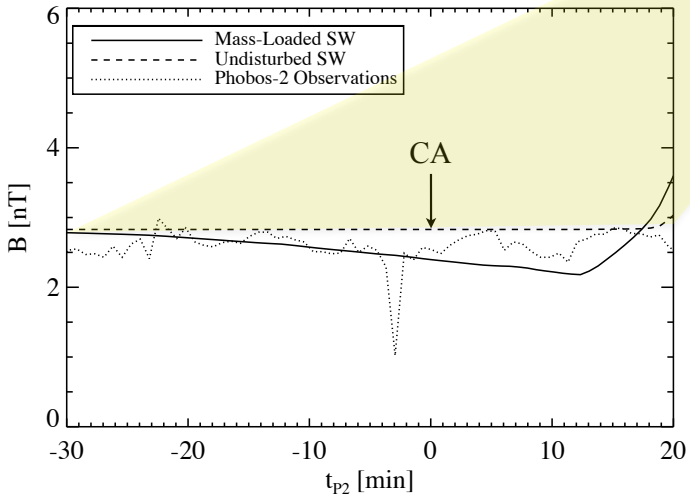


Juhasz et al., 2014

Hint: “Phobos event” (1989)

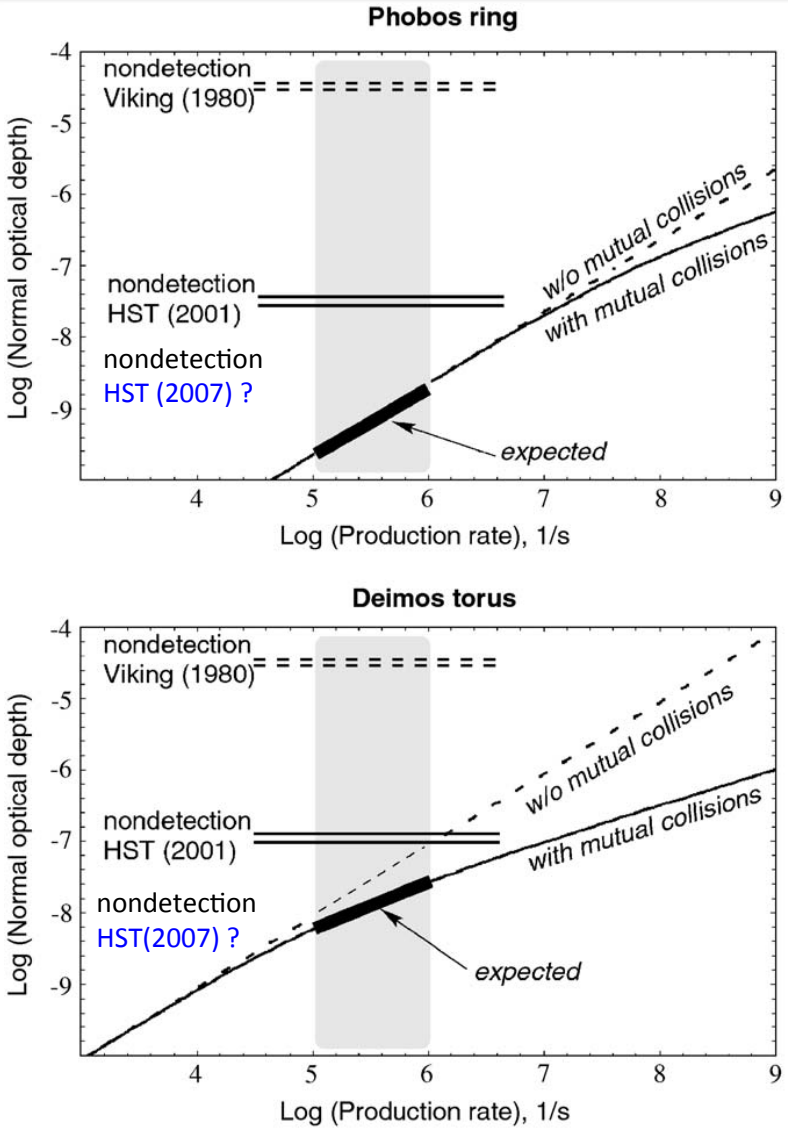






Dubinin et al., 1990
Baumgartel et al., 1996
Zakharov et al., 2014
Rasca et al., 2014

Normal optical depth estimates



Takes decades to 'fill' the torus !

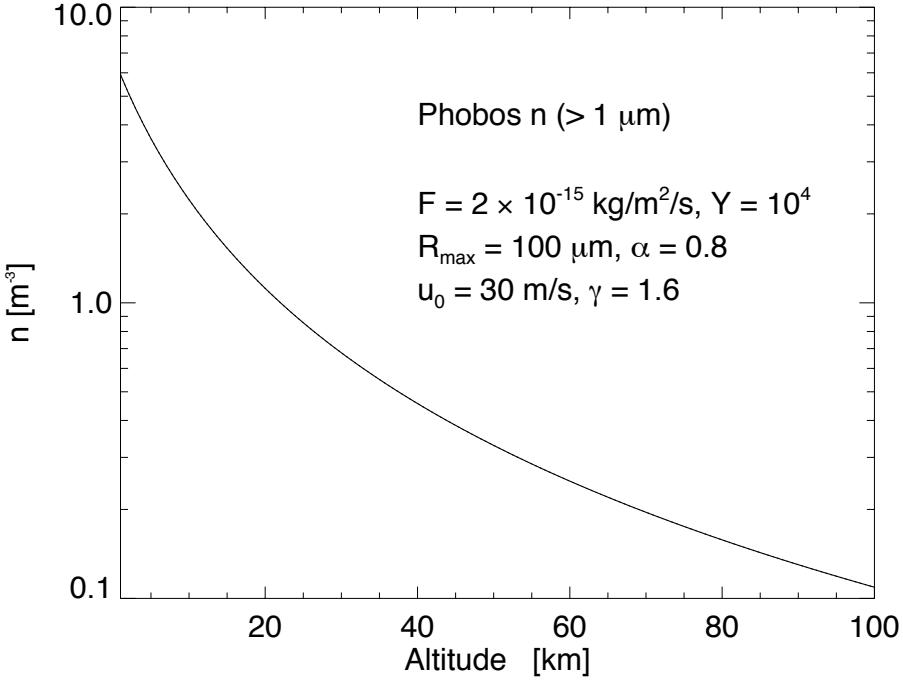
Typical densities ~ 10^{-4} m^{-3}

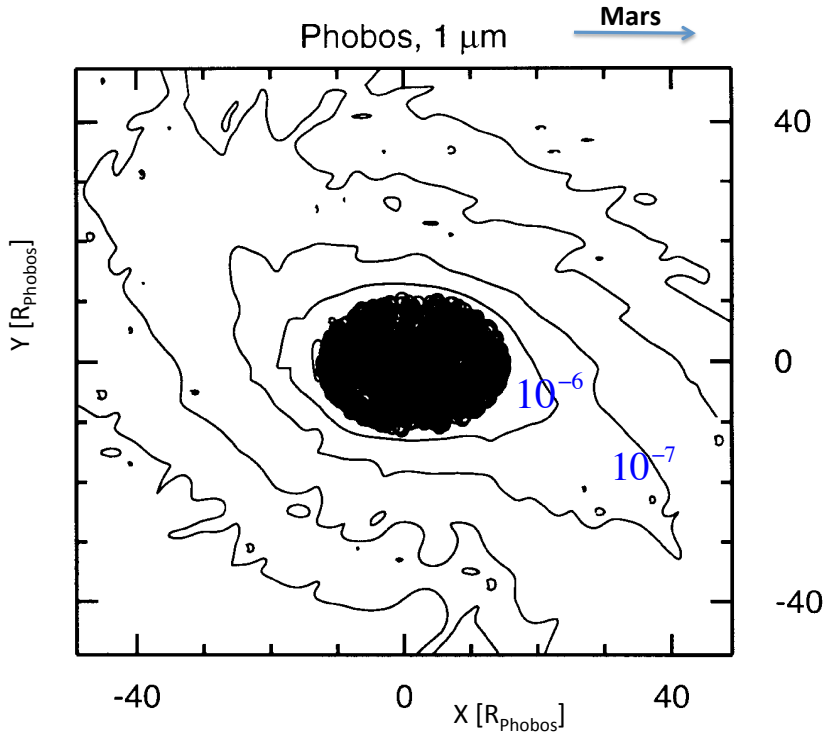
Dominant particle size
(max of lifetime x production rate)
Deimos: 10 - 20 µm
Phobos: 30 - 50 µm

Siding Spring is unlikely to make a 'noticable' effect on the large-scale structure of the dust tori.

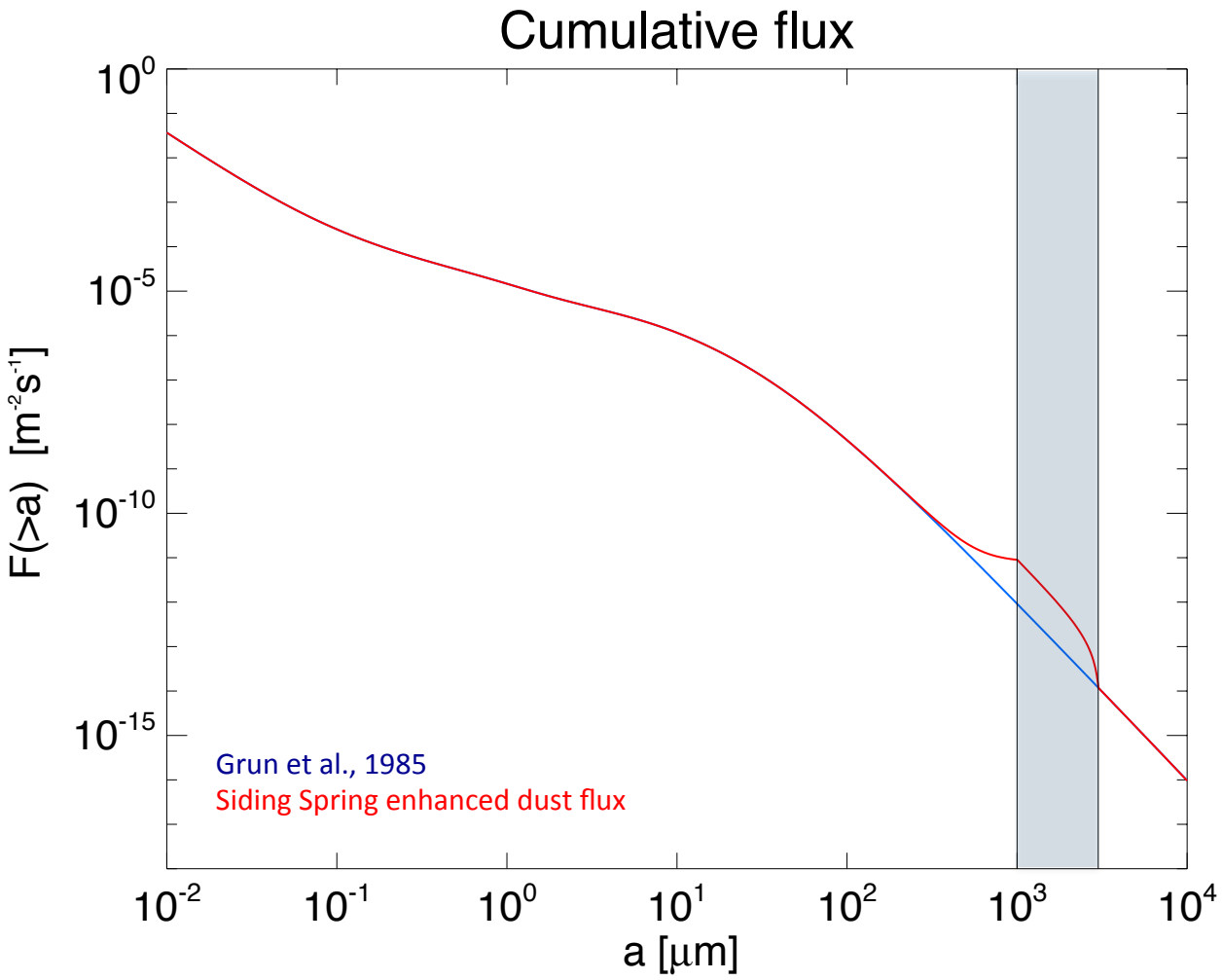
Krivov et al., 2006

Closer look: Expected dust density near Phobos





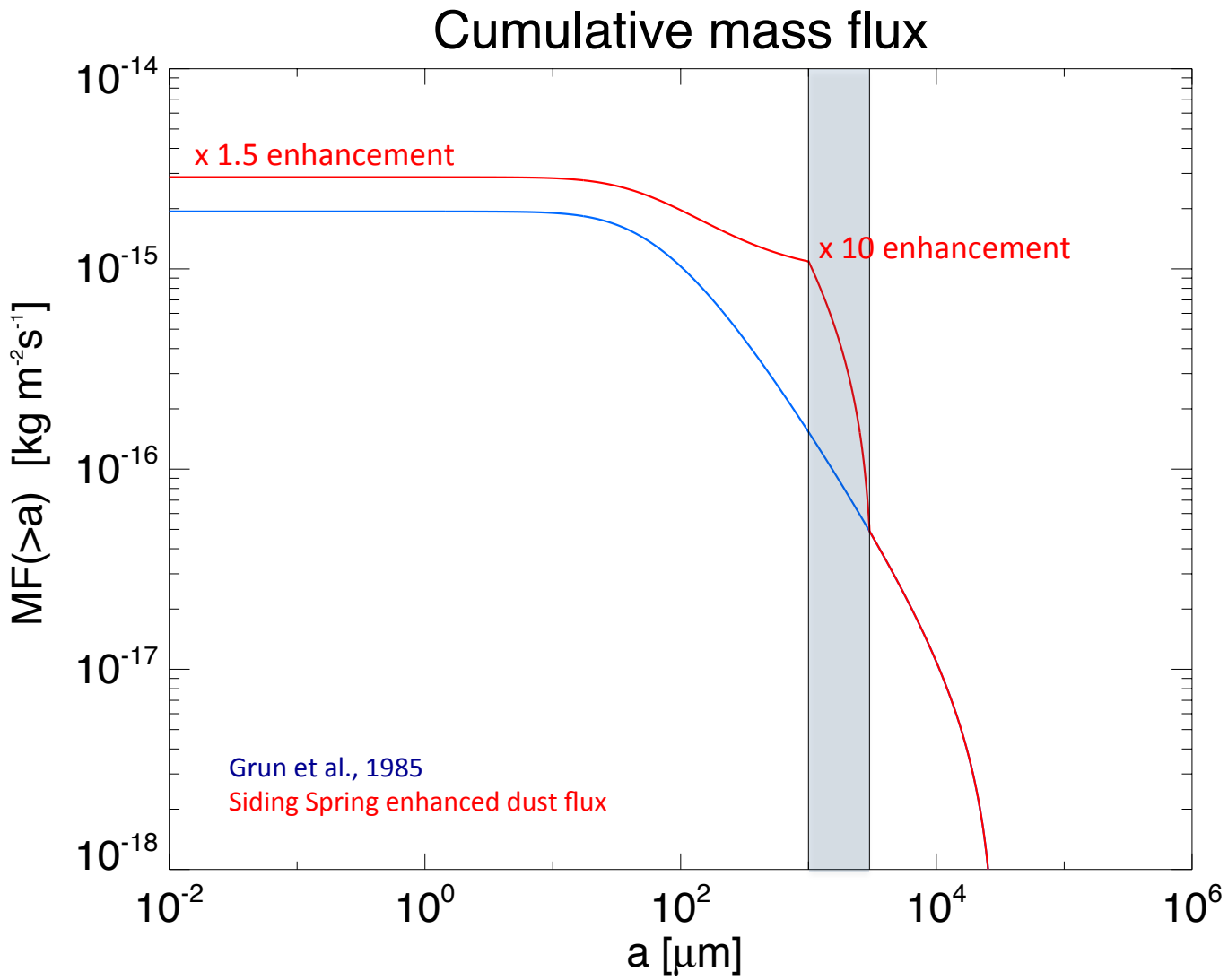
Dust near Phobos/Deimos could be best observed in forward scattered light!

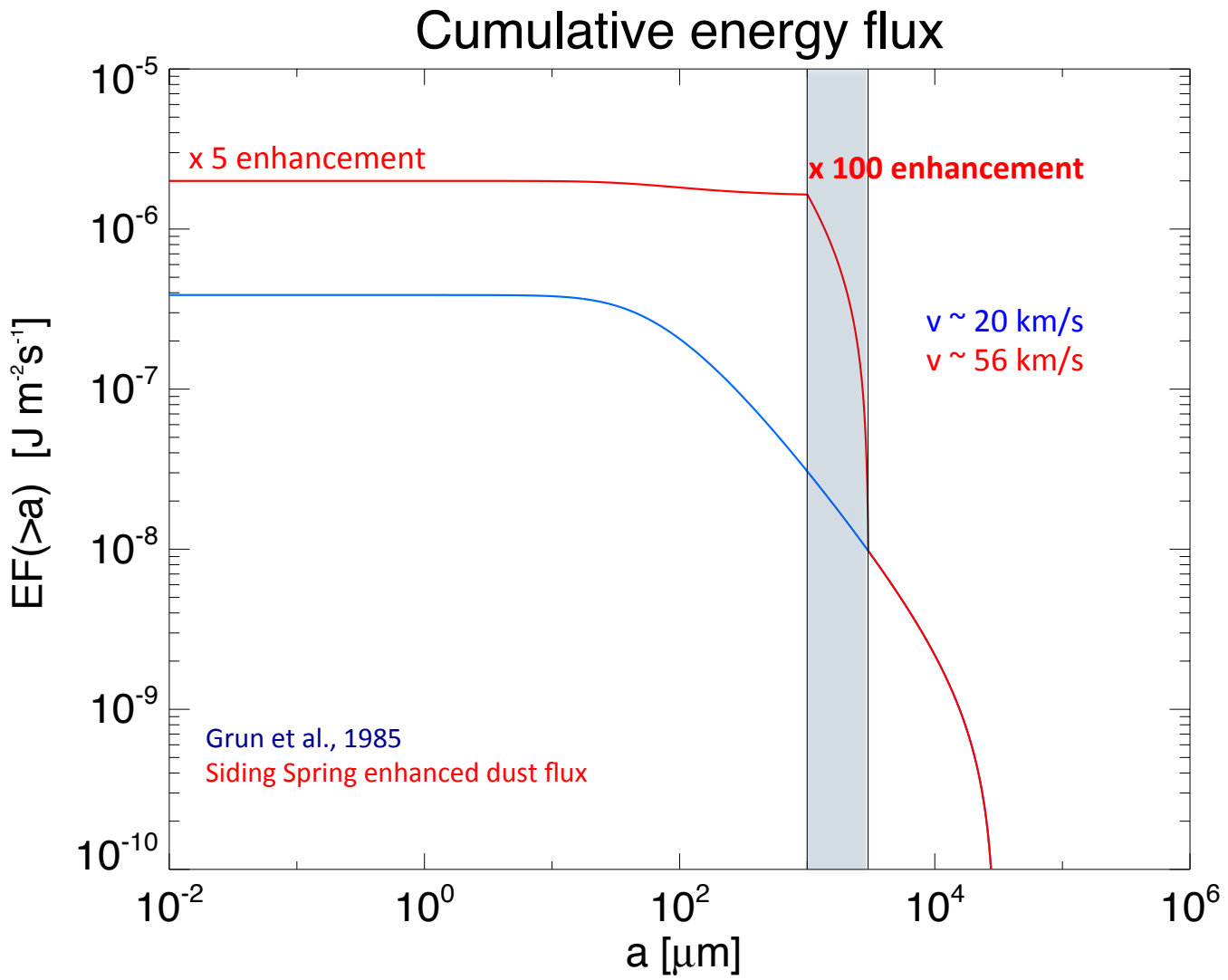


Siding Spring dust @ Mars

Phobos possibly exposed
1 -3 mm radii
~ 10^{-7} grains/m^2
~ 20 minutes

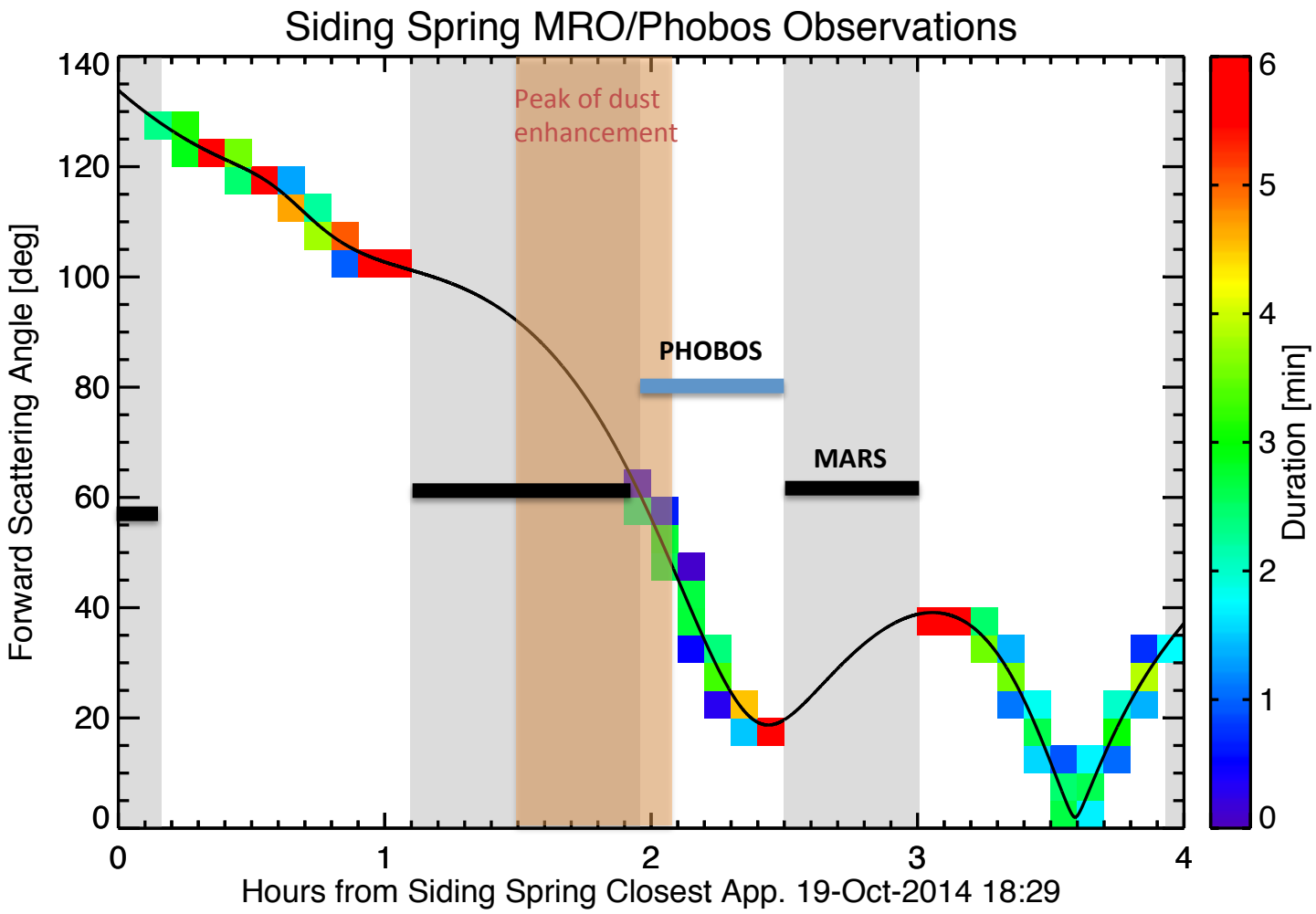
Tricarico et al., 2014
Kelley et al., 2014


Cumulative mass flux
x 1.5 enhancement
x 10 enhancement
Grun et al., 1985
Siding Spring enhanced dust flux
MF(>a) [kg m-2s-1]
10-14
10-15
10-16
10-17
10-18
10-2
100
102
104
106
a [µm]


Cumulative energy flux
x 5 enhancement
x 100 enhancement
v ~ 20 km/s
v ~ 56 km/s
Grun et al., 1985
Siding Spring enhanced dust flux
EF(>a) [J m-2s-1]
a [μm]
10-5
10-6
10-7
10-8
10-9
10-10
10-2
100
102
104
106

Possible MRO observation

180^{o} - Sun/Phobos/MRO angle



Summary

MRO & MOM might observe the continually present ejecta dust clouds at both Phobos and Deimos, as well as a short lived increase in the dust density of <1 to up to 2 orders of magnitude near Phobos following the encounter of comet Siding Spring.

In forward scattered light the brightness due to micron sized and smaller ejecta particles could conspire to be a booming signal, but it will persist only for < minutes after the passing of the enhanced fluxes of cometary dust particles.

If detected, this natural enhancement in the impact flux will help to characterize the development of a dust torus around Mars. The existence of this thin torus has been predicted, but the high-energy impact flux from Siding Spring could provide an excellent opportunity to raise the probability of detection of this phenomenon, and probe the interaction between small body regolith and the space environment.